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November 23, 1999

Martin Zeleznick
U.S. EPA Region IX
75 Hawthorne Street, MS WTR-9
San Francisco, CA 94105

Re: Elk Hills Power Project Wastewater Injection Wells

Dear Mr. Zeleznick:

We represent the California Unions for Reliable Energy ("CURE"). CURE is an intervenor in the California Energy Commission's ("CEC's") permit proceeding for the Elk Hills Power Project ("Project"). The Project is proposed to be located at the Elk Hills Oil Field, approximately 25 miles west of Bakersfield, California.

The Project is proposing to dispose of its wastewater via underground injection wells. The Project is intended to be a stand-alone power plant unrelated to existing activities at the oil field (*i.e.*, it is not a cogeneration facility that will provide steam to enhance oil production). Thus, the injection wells are not related to oil and gas production.

Enclosed is an analysis from William Lettis and Associates ("WLA") that identifies potential impacts associated with the Project's wastewater injection activities. Among other things, WLA has identified what appears to be a large fault near the proposed injection wells. This fault was not identified in any previous studies of the area, and could serve as a conduit for Project wastewater to move between the deeper, lower-quality Tulare aquifer and the shallower, higher-quality Buena Vista Valley aquifer. If this conduit exists, injection of Project wastewater could degrade the water quality in the Buena Vista aquifer, which is used for crop irrigation and other purposes.

The location of the Project's wastewater injection may also cause fault creep and damage the integrity of the Tulare Clay layer, which acts as a barrier to groundwater migration from the deeper aquifers to the shallower aquifers in parts of the San Joaquin Valley. WLA's analysis recommends specific steps that should be taken to adequately assess these impacts and the need for mitigation.

We bring these issues to your attention so you can consider them in your review and permitting of the Project's injection wells under the Safe Drinking Water Act, 42 U.S.C. § 300h *et seq*. As you know, the SDWA prohibits underground injection under the following circumstances:

> [I]f such injection may result in the presence in underground water which supplies or can reasonably be expected to supply any public water system of any contaminant, and if the presence of such contaminant may result in such system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons. (42 U.S.C. § 300h(d)(2).)

In addition to public health impacts, NEPA requires that all environmental impacts of the Project, as well as mitigation measures and project alternatives, be analyzed before EPA issues a permit. (42 U.S.C. § 4332; 40 CFR Part 1500.)

Please contact us if you have any questions about our comments. Please also place us on the notice list (on behalf of CURE) for all Project-related activity.

Thank you for considering our concerns.

Very truly yours,

Lizanne Reynolds

Lizanne Reynolds

LR:bh
Enclosure

WLA

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Ms. Lizanne Reynolds
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16 November, 1999

Dear Ms. Reynolds:

This letter presents comments and issues from the William Lettis & Associates, Inc. (WLA) review of the proposed Elk Hills Power Plant project (EHPP), located on the former Naval Petroleum Reserve No. 1 (NPR-1) in Kern County, California. We have specifically focused our evaluation on geologic issues related to the proposed wastewater injection wells (injection wells) that are proposed for disposal of power plant blowdown water.

SCOPE OF REVIEW

The following scope of work was performed during our review:

- review of the Application for Certification (AFC) for the project, prepared by Foster Wheeler Environmental Corporation, February, 1999;
- compilation and review of published geologic literature and maps for the Elk Hills area (see attached reference list);
- compilation and review of unpublished geological and environmental consultant reports prepared for the project and for previous operations at the NPR-1 oil field (provided by applicant);
- examination of two sets of stereo aerial photographs for the area (WAC 91CA, 1991: USGS 6918); and
- preparation of this letter.

SUMMARY

Based on our review, we believe that the geologic and hydrogeologic conditions have not been adequately characterized in the AFC to fully evaluate possible impacts related to the proposed injection well scheme. Regional and offsite geologic and hydrogeologic information was reviewed by the applicant and presented in the AFC, but site- and project-specific data were not collected or analyzed. The currently proposed injection scheme relies on the integrity of the "Tulare Clay" layer to act as a barrier to prevent migration of contaminated injection water and brackish formation water from the receiving Tulare Formation into the adjacent and overlying fresh Buena Vista Valley alluvial aquifer. The continuity, permeability/transmissivity, and structural integrity of the Tulare Clay at the injection well site has not been verified through subsurface exploration, in-situ borehole testing, or laboratory index testing.

Regional and local faulting, folding, and fracturing of the Tulare Formation and Tulare Clay have not been adequately characterized to evaluate structural influences on groundwater migration. An apparent, continuos fault zone was observed on aerial photographs that cuts through the Tulare Clay and older alluvial deposits just north of the proposed injection well field (Figures 1 and 2). This possible fault was not described or evaluated in the AFC, and could disrupt the structural

integrity of the Tulare Clay as an aquiclude and/or influence injected water migration pathways. It also may represent a potential fault rupture or earthquake hazard. Wastewater injection could cause triggered creep or displacement along this or other buried faults in the vicinity of the proposed well field.

Existing groundwater test data presented in the AFC is inadequate to confirm that past and current deep well injection into the Tulare Formation on adjacent properties has not negatively affected the quality of the Buena Vista Valley alluvial aquifer. Additional studies, including site-specific subsurface and in situ studies, are necessary to address possible impacts from the EHPP wastewater injection scheme.

BACKGROUND

The AFC provides a general overview of the site geology and potential geologic considerations that could impact the suitability of the site for disposal of EHPP wastewater. According to the AFC, two wastewater injection wells will be constructed near an existing well field located along the south flank of the Elk Hills. The EHPP wells reportedly will be drilled to a depth of approximately 1,500 feet, and will be perforated within the upper aquifer of the Pliocene-age Tulare Formation bedrock. According to the AFC, the upper Tulare aquifer is a poor-quality, exempt aquifer currently permitted to receive oil field wastewater by the California Division of Oil, Gas, and Geothermal Resources (DOGGR). The EHPP disposal wells will be fed by a 4.4 mile long, 6-inch pipeline from the power plant. The AFC states that the receiving zone in the Tulare Formation is hydrogeologically isolated from surrounding groundwater aquifers, such as the adjacent alluvial aquifer in the Buena Vista Valley, by a thick clay layer in the upper Tulare Formation called the "Tulare Clay" (Milliken, 1992). Water is pumped from the Buena Vista Valley alluvium for agricultural irrigation. The AFC presents data from previous geologic and hydrogeologic studies performed for the NPR-1 by Milliken (1992 and 1993), various consultants (e.g., Philips, 1992), and background geologic studies by the U.S. Geological Survey (e.g., Woodring and others, 1932; Maher and others, 1975). No new site-specific geologic data are presented in the AFC.

The following discussion focuses on potential geologic-hydrogeologic issues identified during our review of the AFC and supporting documents. We note that some of these issues were previously presented in the August, 1999 Data Request submitted by Adams, Broadwell, Joseph and Cardozo on behalf of CURE. Some of the issues were addressed, or partly addressed, in the applicant's "Response to CURE Data Requests", dated September 7, 1999. However, a number of the previously-presented WLA issues were either not addressed, or inadequately addressed, and have therefore been reiterated in this review letter. Specific comments and issues are listed below.

SPECIFIC ISSUES

1. Site-specific geologic, subsurface, and hydrogeologic investigations have not been performed to adequately characterize the injection field. Existing reports and data provide useful regional and background information, but do not characterize specific conditions at the proposed EHPP discharge well site located south of existing discharge well fields.

    a. Existing wells and geologic mapping show that beds within the Tulare Formation locally exhibit dramatic changes in thickness, composition, and stratigraphy (lateral facies changes). For example, Milliken (1992) notes that the Tulare Clay changes character from a 250-foot thick solid clay layer in Well 82WS-14B located about 2,000 south of the proposed EHPP injection well site ("Tulare Clay type log"), to a 190-foot thick sequence of interbedded sandy gravel and clay (69% gravel, 31% clay) where it crops out along the south flank of the Elk Hills just north of the

injection well site. We note that Milliken's (1992) stratigraphic section through the exposed Tulare Clay north of the injection well site actually consists of a greater percentage of sandy gravel than clay. The inherent local heterogeneity in stratigraphy and clay composition of the Tulare Formation argues against the use of regional or offsite data to evaluate possible impacts from the proposed discharge wells because the Tulare Formation is highly variable.

b. The proposed injection scheme relies solely on the integrity of the Tulare Clay to act as a positive barrier (aquiclude) between contaminated injection formation water and the usable unconfined fresh aquifer in Buena Vista Valley alluvium above the clay. Positive separation of aquifers requires a continuous, intact, low permeability layer. Additional data is necessary to verify the continuity and low permeability of the Tulare Clay layer in the direct vicinity of the proposed EHPP injection wells.

2. Qualitative and quantitative field and laboratory tests and analyses have not been performed on borehole or outcrop samples of the Tulare Clay to define mechanical and permeability/transmissivity properties. This information is necessary to evaluate the effectiveness of the Tulare Clay as an aquiclude, and to model hydrofracture susceptibility of the Tulare Clay beds.

3. Subsurface data from existing wells in the oil field is extrapolated over 2,000 feet (in map plan view) without local control points at the proposed EHPP discharge well field (e.g., AFC Attachment 5). The various contour maps and cross sections therefore are averaged across this interval, and could "hide" (fail to reveal) important structural or geologic features, and local variances in conditions important to the discharge well operations.

4. The Elk Hills are located in an area of active seismic and tectonic activity. Folding and faulting of the Tulare Formation in the Elk Hills indicate that significant post-deposition deformation has occurred, and likely is still ongoing.

   a. We observed an apparent, east-west trending, continuous (4-mile long) fault in the Tulare Formation and younger alluvial fans (Pleistocene-Holocene) along the base of the Elk Hills immediately north of the EHPP discharge well site (Figures 1 and 2). This apparent fault is not referenced or shown on AFC maps. The apparent fault has a relatively strong geomorphic expression on Tulare Formation and old alluvial fan surfaces, and appears to exhibit measurable strike slip and vertical throw that can be observed in aerial photographs. Drainage swales and bedrock ridges are apparently offset across the fault zone. Milliken (1992), while not recognizing this structure, notes a significant southward steepening of Tulare Formation beds in the vicinity of this fault zone, suggesting a possible correlation between faulting and deformation of the Tulare Formation. The cross section in AFC Figure 5.4-5 shows a distinct inflection or "bend" in the Tulare Clay below the proposed injection well field. Such inflections mark locations of potential stress accumulation, and often delineate areas subject to fracturing or development of faults in response to regional tectonic stress. The apparent fault observed by WLA in aerial photographs appears to be similar to the northwest-trending Tupman fault referenced in Milliken (1993) along the north margin of the Elk Hills. In addition, a series of south-vergent thrust faults are shown in the vicinity of the disposal well site on AFC Figure 5.4-5.

   b. The apparent "south margin" fault should be inspected in the field. If this feature is field-confirmed to be a fault, then additional geologic mapping and borehole evaluation should be performed to determine fault geometry and relationship to the Tulare Clay.

c. Milliken (1993, page 26) states that "...faults in the Tulare Clay have profound effects on groundwater distribution at Elk Hills". The influence of faults and fractures in the Tulare Clay as potential groundwater barriers or migration paths has not been established, and requires further characterization.

5. Historic creep movements along the Buena Vista thrust fault, located south of the proposed EHPP site, have caused shearing of existing wells. AFC Figure 5.4-5 suggests that thrust faults occur just north of the EHPP discharge well field. Additionally, page 5.5-7 of the AFC lists potentially active "Boundary Zone Blind Thrusts" within 5 miles of the site. Similar potentially active thrust or buried faults could occur in the Tulare Formation in the vicinity of the disposal well field. The geometry of the Elk Hills fold suggests that potentially "blind" (subsurface) thrust faults or fractures could exist along the south margin of the hills, at the location of the proposed well field.

   a. If confirmed, the south margin fault could pose a surface fault rupture or earthquake hazard to the disposal wells or pipeline.

   b. Wastewater injection could cause triggered creep or displacement along the south margin fault of buried thrust faults. This could result in shearing of the disposal well casings or affect the structural and hydrogeologic integrity of the Tulare Clay.

6. The AFC and supporting documents discuss previous geochemical testing of upper Tulare Formation water samples from extraction wells located 4,000 feet downgradient from existing injection wells. The results from the geochemical testing are used to argue that existing and past injection operations have not impacted the water quality. However, there do not appear to be sufficient data to support this conclusion.

   a. The tested wells are within the Tulare Formation downgradient from existing injection wells. No groundwater data is provided from the alluvial aquifer adjacent to the injection field. Such data is necessary with a reasonable degree of confidence show that existing injection activities in the Tulare Formation have not impacted water quality in the alluvial aquifer. We recommend that this data be gathered and analyzed before approval of additional injection wells associated with the EHPP project.

   b. The well sampling period extends for a ten-year time span since initiation of the oil field injection program. Referenced transmissivity values for the Tulare Formation aquifer in the well field are between 50 and 700 feet per year. Using the reported distance between the injection wells and monitoring wells, a time lag of between 6 and 80 years would be required before contaminants would migrate to the test wells (assuming uniform transmissivity rate and homogenous aquifer conditions). This suggests that a sufficient amount of time has not passed for the contaminant front to reach the test wells. Thus, this sampling data does not provide sufficient evidence to conclude that the existing injection wells will not impact the shallow aquifer.

CONCLUSIONS

The following issues have not been adequately addressed in the AFC to assess impacts related to the proposed EHPP wastewater injection scheme. Until further studies are performed, these issues cannot be properly addressed.

- No site- or project-specific information has been collected or analyzed to confirm geologic and hydrogeologic conditions at the proposed injection well field. The Tulare Formation and Tulare Clay vary in composition along the south flank of the Elk Hills, and regional or offsite geologic and hydrogeologic information is not adequate to verify that injection water will not migrate offsite and contaminate the adjacent Buena Vista Valley alluvial aquifer.

- The physical and mechanical properties of the Tulare Clay at the proposed injection well site have not been documented by laboratory testing of borehole or outcrop samples. Laboratory testing on representative samples should be performed to verify the behavior of the Tulare Clay and model assumptions.

- Faults, folds, and fractures in the Tulare Formation affect the structural integrity of the Tulare Clay. These structural features could permit migration of injection water from the receiving Tulare Formation into the Buena Vista Valley alluvium. Additional characterization of local and subsurface geologic conditions is necessary to evaluate and model structural influences on groundwater migration.

- Potential faults were observed on aerial photographs in the Tulare Clay and older alluvial fan surfaces along the south margin of the Elk Hills just north of the EHPP injection well field. These features should be inspected in the field, and further characterized if confirmed to be faults. Potential fault rupture and earthquake hazard to the injection wells and pipeline should be addressed. Rupture hazard from creep or triggered slip along surface and potential buried (blind) faults in the injection well field area should be addressed.

- The potential for injection-triggered creep or displacement along nearby and potentially buried faults needs to be specifically addressed.

- In situ testing (geophysical surveys, borehole pump/packer tests) have not been performed to evaluate site-specific aquifer and aquiclude characteristics. AFC assumptions regarding radius of injection well influence and hydrofracture potential are based on regional or offsite data that likely are not representative of the site geologic and hydrogeologic conditions.

- Existing well geochemical test data referenced in the AFC are confined to wastewater from the Tulare Formation aquifer, and do not include data from the adjacent Buena Vista alluvial aquifer. Therefore, this data does not confirm that past and current deep well injection activities on the south flank of the Elk Hills have not impacted the Buena Vista Valley alluvial aquifer water quality.

- Additional information is necessary to evaluate impacts related to the proposed EHPP wastewater injection scheme. The following studies would provide necessary additional information to evaluate project impacts:
  - field inspection of possible faults along the south flank of the Elk Hills;
  - detailed geologic and structural mapping of Tulare Clay outcrops near the EHPP injection well field;
  - collection and testing of Tulare Clay and Tulare Formation aquifer samples;
  - subsurface exploration at the well field site (extended into the Tulare Formation aquifer and below the Tulare Clay);
  - in situ borehole testing (geophysics, pump/packer testing); and
  - installation and sampling of a monitoring well(s) (or hydropunch water samples) in the Buena Vista Valley alluvium adjacent to the proposed EHPP injection well field, and downgradient from existing injection wells.

Please call me at (925) 256-6070 if you have any questions regarding this review letter. Thank you very much.

Sincerely,
WILLIAM LETTIS & ASSOCIATES, INC.

Jeff Bachhuber, C.E.G.
Principal Engineering Geologist

Charles M. Brankman
Staff Geologist

Attachments: Figures 1 and 2

REFERENCES

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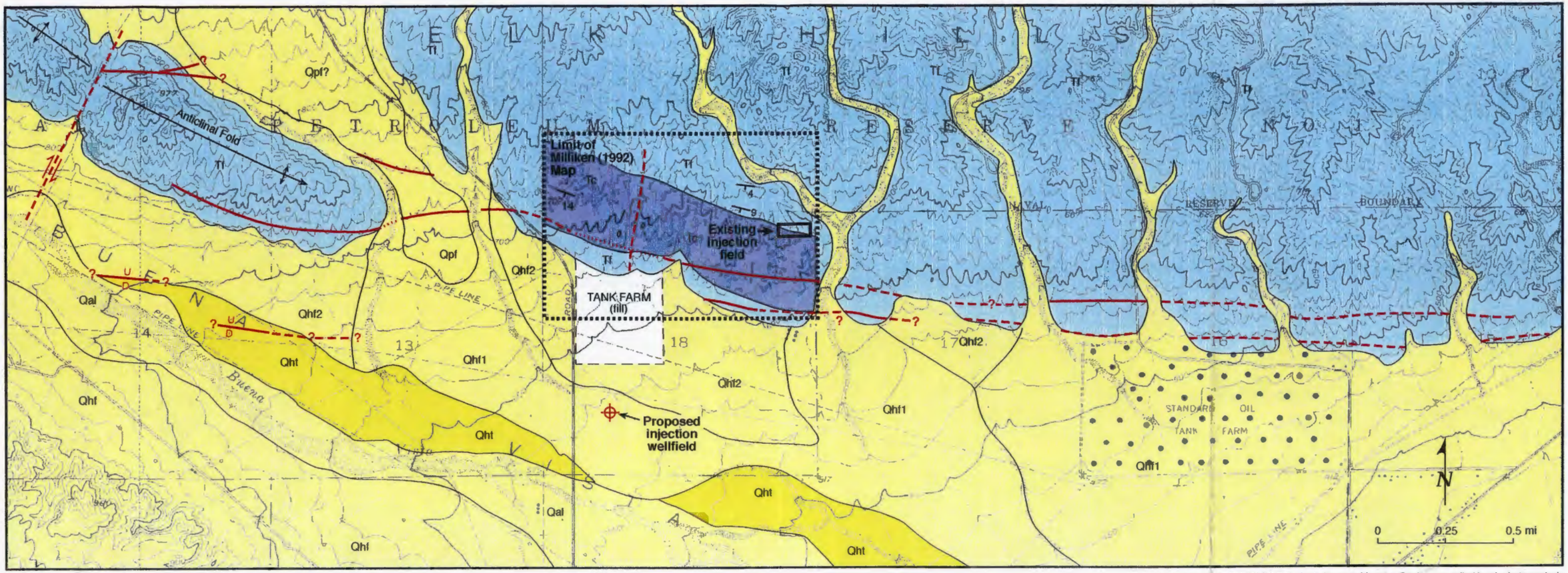

Note: Base map Taft USGS 7.5 minute topographic map. Geology compiled by air photo analysis (William Lettis & Associates), Milliken (1992), and Woodring (1932).

Explanation

Aerial photo lineament interpreted as a fault; solid line denotes well-defined trace; dashed line denotes subtle feature, queried line denotes questionable feature

Alluvium of Buena Vista Valley:

- Qal — Recent (Holocene and active) alluvium along Buena vista Creek: active channel is defined by stipple pattern
- Qht — Holocene stream terrace along Buena Vista creek
- Qhf1 — Younger (Holocene) alluvial fan: active channels are defined by stipple pattern
- Qhf2 — Older (late Pleistocene- early Holocene?) alluvial fan
- Qhf — Holocene to late Pleistocene alluvial fan (undifferentiated)
- Qpf — Old (late Pleistocene?) alluvial fan

Tc — Tulare Clay (as mapped by Milliken, 1992)

Tl — Tulare Formation (undifferentiated)

Anticlinal fold axis

14 — Bedding (strike and dip) of Tulare Formation

WLA

Figure 2. Quaternary Geologic Map of the Proposed EHPP Disposal Well Field Area